

REMARKS

Claims 1-19, all the claims pending in the application, stand rejected. Claims 1, 2, 6 and 7 are cancelled. New claims 20-24 are added. Claims are amended for consistency

New independent claim 20 is a combination of original claims 1 and 2. New independent claim 21 is a combination of original claims 6 and 7. New dependent claims 22-24 are added. New dependent claims 22 and 23 are based on the description on page 10, line 24 to page 11, line 18 in the specification while new dependent claim 24 is based on the description on page 13, line 6 to page 13, line 20 in the specification.

The present invention claimed in new independent claims 20 and 22 relates to a method of producing a reflective mask. An object of the present invention claimed in claims 20 and 21 is to prevent decrease in reflectivity in a reflecting region as a result of deposition of oxide or the like produced on the surface of a reflective multilayer film during a mask production process, for example, a patterning step of an absorber layer and a buffer layer for defining a nonreflecting region to an exposure light.

The present invention claimed in independent claim 11 also relates to a method of producing a reflective mask. An object of the present invention claimed in claim 11 is to prevent decrease in reflectivity in a reflecting region as a result of deposition of oxide or the like produced on the surface of a protection film during a mask production process, for example, a patterning step of an absorber layer and a buffer layer on the protection film for defining a nonreflecting region to an exposure light.

That is, the present invention claimed in new claims 20 and 21, and original claim 11 concerns the problems of the reduction in reflectivity in the surface of the reflecting region as a result of deposition of oxide or the like produced during the mask production process. For example, such production may be during a patterning step of a layer, namely, the absorber layer and buffer layer adjacent to a topmost layer of the reflective multilayer film, or a layer, such as an absorber layer on the protection film.

Claim Rejections – 35 U.S.C. § 103

Claims 1-19 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hoshino (US-2002/0014403) in view of Yokoi et al (US-6,586,145). This rejection is traversed for at least the following reasons.

Yokoi et al

Yokoi et al is concerned with the prevention of a decrease in reflectivity in a reflecting region caused by the patterning of an absorber layer and a buffer layer, where the process uses a solution containing hydrofluoric acid or the like.

However, Yokoi et al, in a case where an SiO₂ buffer layer and a Ta absorber layer are laminated onto a reflective multilayer film, has the following problem. That is, a Ta chloride is deposited onto the surface of the SiO₂ buffer layer during the patterning of the Ta absorber layer with a reactive ion etch, using a chlorine system gas. The deposited Ta chloride obstructs the etching of the SiO₂ buffer layer with the diluted hydrofluoric acid solution. As a result, a taper shape of the SiO₂ buffer layer becomes large, and the bottom edge of the SiO₂ buffer layer projects outside from the bottom edge of the Ta absorber layer. As a result, the projected portion causes a reduction in reflectivity near the side wall.

To solve the problem mentioned above, in Yokoi et al, (1) the Ta chloride deposited onto the surface of the SiO₂ buffer layer is replaced by a fluoridation carbon system deposit that is easy to dissolve in a dilution hydrofluoric acid solution. This is accomplished by carrying out a reactive sputtering under etching using a fluoride system gas to the SiO₂ buffer layer after the etching of the Ta absorber layer. Then, (2) since the Ta chloride deposited onto the pattern side wall remains on the side wall by the side wall protection effect of the fluoride system gas plasma, the taper shape caused by the wet etching carried out after that by using the dilution hydrofluoric acid solution can be controlled to be small. Thus, it is possible to control the projection of the bottom edge of the SiO₂ buffer layer.

The present invention is not concerned with a control of the side wall shape of the pattern. Instead, the invention concerns the removal of the deposit on the exposed surface of the reflective multilayer film.

Hoshino

Hoshino is not concerned with a method of producing the reflective mask. Instead, Hoshino is concerned with a method of fabricating a semiconductor device. In Hoshino, the patterning is carried out to an SiO₂ layer formed onto a polysilicon layer used as a gate electrode with the conventional photolithography and then the patterned layer is narrowed in width by the process with the hydrofluoric acid solution. Subsequently, the under layer, namely, the polysilicon layer, is etched by using the narrowed pattern as a mask. Thereby, a very fine pattern having a resolution higher than that of the photolithography, can be obtained. Clearly, the method of Hoshino is quite different from the present invention in object and use.

As mentioned above, the present invention is not concerned with a control of the side wall shape of the pattern, as disclosed in Yokoi et al and Hoshino, but the remove of the deposit on the exposed surface of the reflective multilayer film.

Although there may be similarities between the present invention and Yokoi et al in certain aspects of the process carried out with the hydrofluoric acid solution after the patterning, the process of the present invention is that carried out after the formation of the buffer layer or the protection film that is not patterned and is carried out after the patterning. The process of the present invention is different in object and required components.

Dependent Claims

The remaining claims are also patentable because these claims depend from any one of patentable claims.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Amendment Under 37 C.F.R. § 1.111
U.S. Application No. 10/802,886

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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